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DAMAGE TO AND ANALYSIS OF
FIRE DEPARTMENT CAPABILITIES,
CITY OF DETROIT

Final Report

March 1969

Contract No. N00228-68-C-1793
OCD Work Unit 2522H



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NRDL-TRC-69-12

**URS 697-5
SD-11101-2522H-02**

**DAMAGE TO AND ANALYSIS OF
FIRE DEPARTMENT CAPABILITIES,
CITY OF DETROIT**

Final Report

March 1969

by

**Milton Staackmann
URS RESEARCH COMPANY
1811 Trousdale Drive, Burlingame, Calif. 94010**

for

**OFFICE OF CIVIL DEFENSE
Office of the Secretary of the Army
Washington, D.C. 20310**

through

**U.S. Naval Radiological Defense Laboratory
San Francisco, California 94135**

**Contract N00228-68-C-1793
Work Unit 2522H
Five-City Stud,**

OCD REVIEW NOTICE

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URS 674-3
Summary



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NRDL-TRC-69-12

**Summary
URS 697-5**

**Summary Report
of
DAMAGE TO AND ANALYSIS OF
FIRE DEPARTMENT CAPABILITIES,
CITY OF DETROIT**

The role of the Five-City-Study fire services in dealing with situations following nuclear attack will depend on how well the fire-service resources survive the attack and the magnitude and kinds of demands placed upon them. The demands facing the fire services are being analyzed in other research efforts. The study reported here evaluated damage to the fire departments of each city as a result of the Five-City-Study attack. The evaluation proceeded through consideration of the following:

1. Strength and location of the fire services prior to the attack
2. Casualties and damage incurred in the fire services as a result of the attack
3. Analysis of the remaining capabilities in the postattack period.

Briefly summarized, the research reported here is for the city of Detroit under conditions of the current plan, which calls for the reserve equipment and a few personnel going to Dispersed Mobilization Points, but with most of the equipment and personnel located near the fire station (no evacuation). The research yielded the following findings:

1. Firefighting personnel would experience total casualties on the order of 60% of their number. Of the remaining uninjured personnel, only about half would be located with their officers and near the assigned fire stations. A few of the other half would be located far outside the city, but most of these would be in shelters located randomly around the city.
2. Only about 20% of the fire stations would be usable after the attack. The communications and repair shop facilities would be inoperable, but the control centers would be completely operable.

Summary
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3. Approximately 30% of all fire-service trucks would be usable after the attack, but less than one-third of these would be available within the city itself at fire stations.
4. Survival of the fire-service trucks would be greatly improved if they were stationed in open areas rather than inside the firehouses. If this strategy had been employed nearly 50% of all trucks would be usable after the attack, with a far greater number available for use within the city than with the indicated preattack posture.
5. The fire services would be completely incapable of dealing successfully with the total postattack fire situation. Due to the damaged fire-service resources and the constraints on mobility imposed by debris-laden streets, orthodox firefighting should be abandoned in favor of the following:
 - a. Augmenting self-help firefighting
 - b. Some limited exposure-control activities at crucial locations
 - c. Attempting to stop any moving-front fires that might threaten critical areas
 - d. Aiding evacuation from areas where uncontrolled fires threaten population survival.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance received during the course of the research effort reported herein. URS Research Company employees who contributed include: Stanley B. Martin, who initiated, managed, and gave much aid to the project; James E. Edmunds, Carl R. Foget, and Carolee A. Start. Louis E. Almgren of Gage-Babcock & Associates, Inc. provided fire department information. Dr. Mathew G. Gibbons of the U.S. Naval Radiological Defense Laboratory was the Technical Monitor and provided much appreciated understanding and patience.

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ABSTRACT

This study examines damage to the Detroit Fire Department as a result of the Five-City-Study attack and analyzes the capabilities of the Fire Department in dealing with the postattack fire situation. After reviewing damage incurred by personnel, facilities, and trucks, the remaining fire-service resources were evaluated with respect to the magnitude of the demand situation and obstacles preventing the satisfaction of the demands.

SUMMARY

The role of the Five-City-Study fire services in dealing with situations following nuclear attack will depend on how well the fire-service resources survive the attack and the magnitude and kinds of demands placed upon them. The demands facing the fire services are being analyzed in other research efforts. The study reported here evaluated damage to the fire departments of each city as a result of the Five-City-Study attack. The evaluation proceeded through consideration of the following:

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2. Only about 20% of the fire stations would be usable after the attack. The communications and repair shop facilities would be inoperable, but the control centers would be completely operable.
3. Approximately 30% of all fire-service trucks would be usable after the attack, but less than one-third of these would be available within the city itself at fire stations.

4. Survival of the fire-service trucks would be greatly improved if they were stationed in open areas rather than inside the firehouses. If this strategy had been employed, nearly 50% of all trucks would be usable after the attack, with a far greater number available for use within the city than with the indicated preattack posture.
5. The fire services would be completely incapable of dealing successfully with the total postattack fire situation. Due to the damaged fire-service resources and the constraints on mobility imposed by debris-laden streets, orthodox firefighting should be abandoned in favor of the following:
 1. Augmenting self-help firefighting
 2. Some limited exposure-control activities at crucial locations
 3. Attempting to stop any moving-front fires that might threaten critical areas
 4. Aiding evacuation from areas where uncontrolled fires threaten population survival.

Section 1
INTRODUCTION

This report is one of five similar reports submitted under the provisions of Contract Number N00228-68-C-1793 between U.S. Naval Radiological Defense Laboratory and URS Research Company. The purpose of this report is to calculate the damage to the Detroit Fire Department due to a postulated nuclear weapon detonation (Ref. 1). The research effort of all five reports represents a component study (Work Unit 2522H) of the Five-City Study being conducted by the Office of Civil Defense.

BACKGROUND

Previous research concerning fire-service capabilities was performed by URS under Contract N00228-67-C-0694 (OCD Work Units 2512A and 1511E). Work under this contract was primarily devoted to developing a generalized analytic scheme for evaluating the probable effectiveness of the fire services in handling requirements for damage control and rescue after nuclear attack (Ref. 2). In addition, the preattack distribution of fire-service resources for the five cities was determined and a preliminary analysis of the damage to the fire services for downtown San Jose was performed (Ref. 3). Other research work concerning fire-service capabilities was performed under Contract N00228-67-C-0710 (OCD Work Unit 2538C, Ref. 4). Under this contract, effort was directed at the development of an interim general model for calculation of the buildup and spread of fire in selected cities as a result of the nuclear attack specified in the Five-City Study. The results of all of the above effort have been utilized as appropriate in the preparation of this report.

SCOPE OF WORK

The five reports submitted under the current contract encompass the calculation and analysis of the damage to the fire departments in the cities of

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San Jose, Albuquerque, New Orleans, Providence, and Detroit as a result of the Five-City Study attack (Ref. 1). The output includes the following items for each city:

1. An analysis of the damage to and remaining capabilities of each fire department in the area
2. A map overlay showing surviving usable facilities and the nature of damage to unusable facilities
3. Tabulations of surviving usable equipment (trucks) and of the unusable equipment with the nature of damage indicated.

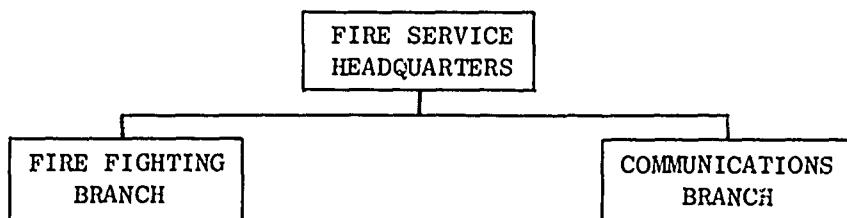
Results for each of the five cities are bound separately. This report gives the results for the city of Detroit. Submission of the five reports constitutes completion of the subject contract.

Section 2
PREATTAKE DISTRIBUTION OF RESOURCES

The actual location of the various fire department resources at the time of the postulated attack is determined by the situation established in the Detroit attack preparation scenario (Ref. 5), the instructions embodied in the Fire Department Civil Defense Standard Operating Procedures (Ref. 6) and the current roster of resources of the Detroit Fire Department.

According to the attack preparation scenario, Detroit would have been brought up to the highest level of preparedness for nuclear attack, with an estimated 90% of the population sheltered according to plan. No general evacuation has been ordered or has taken place, but it is estimated that about 10% of the population has evacuated the city. The Civil Defense Main Control Center has been placed on a 24-hour basis manned at 50% strength. The fire department has augmented its personnel by intensive recruitment and training (it is estimated that this augmentation has increased the personnel in fire fighting units by about 10%). All non-routine street and highway equipment containing radio communications has been dispersed to preselected control points.

Given the crisis buildup period as described in the above scenario, fire department responses to the situation have been identified as indicated in the Standard Operating Procedures. The Detroit Fire Service for Civil Defense is organized basically as depicted below:



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The Main and Alternate Fire Service Headquarters are located at the Civil Defense Main and Alternate Control Centers, respectively. The headquarters are fully manned with Detroit Fire Department Headquarters and Communications Division personnel. Assigned personnel from the Firefighting Division and reserve fire department trucks have moved to Dispersed Mobilization Points and communications have been activated. The remainder of the Detroit Fire Department personnel have manned the normal fire stations on a two-platoon, 24-hour basis until the move-to-shelter signal was given, at which time all personnel take cover along with the public.

The locations of all fire department facilities are shown in Fig. 1, which also indicates the ground zero location for the attack and corresponding overpressure contours of interest.

The locations of all personnel, trucks, and facilities at the time of the postulated attack are given in Tables 1 and 1a. It is assumed that all duty stations are being manned on a 24-hour basis at 50% strength. The 50% on-duty personnel will find shelter at attack time either in their facilities or in shelters located in the local Standard Location Area of their facility. The 50% off-duty personnel are assumed to find shelter at random in shelters across the city.

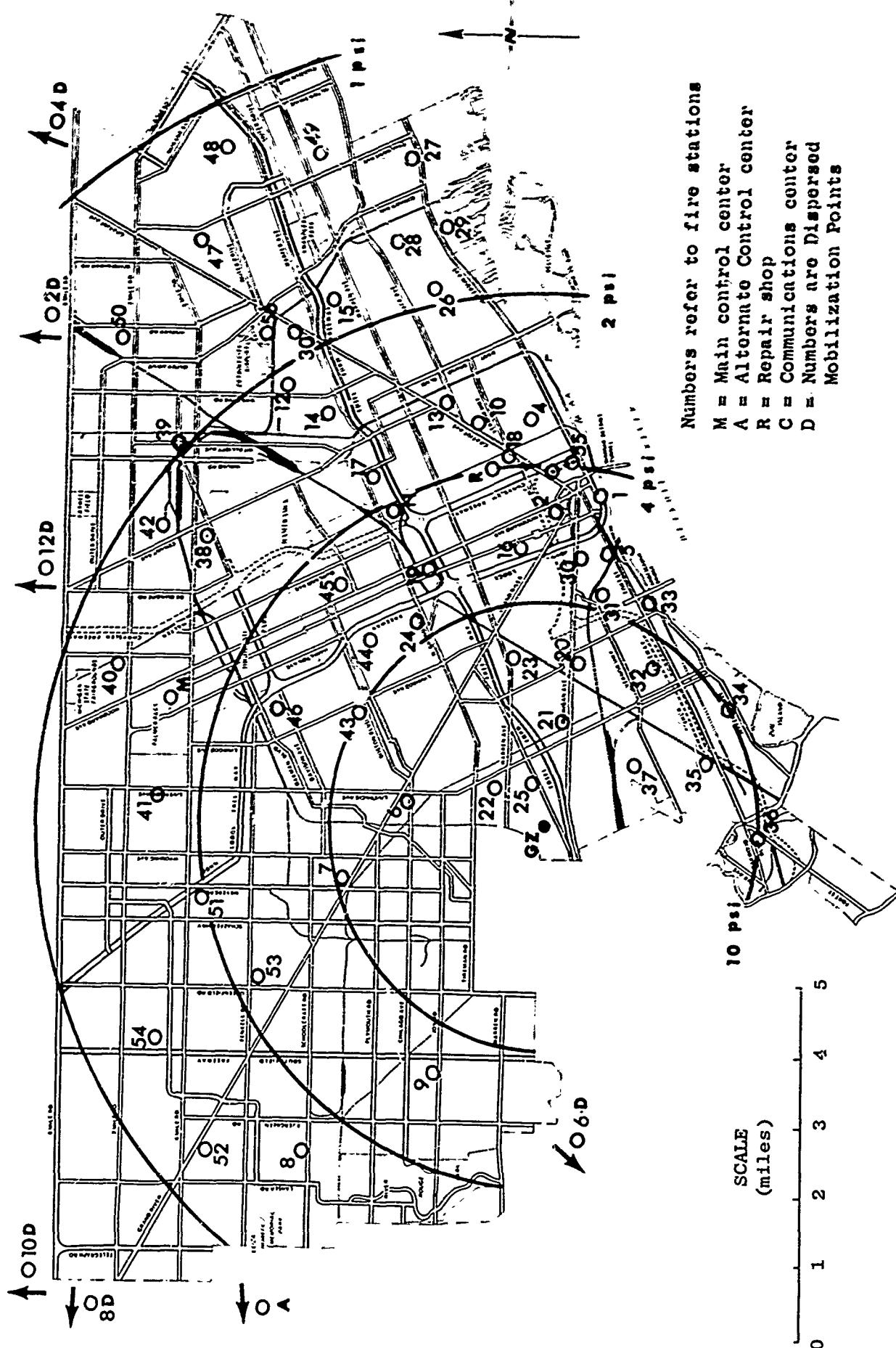


Figure 1. Location of Detroit Fire Department Facilities

Table 1
**LOCATION OF DETROIT FIRE DEPARTMENT PERSONNEL, TRUCKS,
AND FACILITIES AT POSTULATED ATTACK TIME**

Facility Location	Address	Personnel	Trucks
Main Control Center	900 Merrill Plaisance Palmer Park, Detroit	(See Table 1a)	---
Alternate Control Center	Detroit House of Correction Phoenix Road (Five Mile Road) West of Beck Road Plymouth, Michigan	(See Table 1a)	
<u>Dispersed Mobilization Points:</u>			
2-D Utica	Kroger Market Van Dyke & Gerhardt	2 Battalion Chiefs 10 Firefighters	2 pumper 1 ladder truck 1 boat tender 1 disaster unit
4-D Richmond	Richmond Fire Department 69441 N. Main St.	2 Battalion Chiefs 1 Physician* 10 Firefighters	2 pumper 1 ladder truck 1 squad truck 1 foam truck
6-D Flat Rock	Flat Rock Speedway Telegraph & Newberg Road	2 Battalion Chiefs 1 Physician 8 Firefighters	2 pumper 1 ladder truck 1 disaster unit
8-D Northville	Northville Municipal Bldg. W. Main and Wing	2 Battalion Chiefs 10 Firefighters	2 pumper 1 ladder truck 1 squad truck 1 foam truck
10-D Bloomfield (Pontiac)	Bloomfield Fire Department 4200 Telegraph (South of W. Long Lake Rd.)	2 Battalion Chiefs 1 Physician 10 Firefighters	2 pumper 1 ladder truck 1 hose truck 1 foam truck
12-D Rochester	Brooklands Fire Department 1725 Auburn Rd., M-59 (West of Dequindre)	2 Battalion Chiefs 10 Firefighters	2 pumper 1 ladder truck 1 squad truck 1 foam truck

* The three Physicians of the Fire Department Medical Division are shown in their Fire-Service assignments here, but may be located elsewhere since they are also assigned to the Medical Service for Civil Defense purposes.

Table 1 (Continued)

Facility Location	Address	Personnel	Trucks
Normal Fire Department Headquarters and Station No. 1	250 W. Larned	56 from Fire Marshall Division 2 from Water Supply Division 3 Chiefs 64 Firefighters	1 pumper 1 ladder truck 1 squad truck 1 boat tender 1 ambulance
Apparatus Division & Building & Supplies Depot (repair shop)	1400 Erskine	66 from Apparatus Division	---
Communications Div.	697 Macomb	---	---
Station No. 2	111 W. Montcalm	3 Chiefs* 36 Firefighters	1 pumper 1 ladder truck
Station No. 3	1205 Bagley	3 Chiefs 18 Firefighters	1 pumper
Station No. 4	652 Elmwood	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 5	1625 W. Lafayette	3 Chiefs 18 Firefighters	1 ladder truck
Station No. 6	6324 W. Chicago	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 7	12515 Grand River	3 Chiefs 18 Firefighters	1 pumper
Station No. 8	13960 Burt Road	3 Chiefs 18 Firefighters	1 pumper
Station No. 9	18140 Joy Road	4 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 10	2737 Gartiot	3 Chiefs 18 Firefighters	1 pumper
Station No. 11	1818 E. Grand Blvd.	4 Chiefs 18 Firefighters	1 pumper

* The word Chief as used throughout Table 1 is to denote officer-level personnel.

Table 1 (Continued)

Facility Location	Address	Personnel	Trucks
Station No. 12	10101 Knodell	3 Chiefs 18 Firefighters	1 pumper
Station No. 13	3812 Mt. Elliott	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 14	7000 Miller	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 15	10700 Shoemaker	3 Chiefs 18 Firefighters	1 ladder truck
Station No. 16	433 W. Alexandrine	3 Chiefs 50 Firefighters	1 pumper 1 ladder truck 1 squad truck
Station No. 17	1475 E. Milwaukee	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 18	Russell & Wilkins	3 Chiefs 36 Firefighters	1 pumper
Station No. 19	6100 - 2nd Blvd.	4 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 20	3396 Vinewood	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 21	6140 Michigan	3 Chiefs 18 Firefighters	1 pumper
Station No. 22	6535 Livernois	3 Chiefs 18 Firefighters	1 pumper
Station No. 23 & Training Academy	2775 W. Warren	3 Chiefs 37 Firefighters 4 from Training Division	1 pumper 1 ladder truck 1 light unit
Station No. 24	1697 W. Grand Blvd.	4 Chiefs 36 Firefighters	1 pumper 1 squad truck
Station No. 25	6830 McGraw	3 Chiefs 18 Firefighters	1 ladder truck
Station No. 26	2200 Crane	3 Chiefs 36 Firefighters	1 pumper 1 ladder truck

Table 1 (Continued)

Facility Location	Address	Personnel	Trucks
Station No. 27	1113 Coplin	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 28	3872 St. Jean	3 Chiefs 18 Firefighters	1 pumper
Station No. 29	11740 E. Jefferson	4 Chiefs 18 Firefighters	1 pumper
Station No. 30	5000 Rohns	3 Chiefs 34 Firefighters	1 pumper 1 squad truck
Station No. 31	1031 - 18th Street	3 Chiefs 18 Firefighters	
Station No. 32	1468 Junction	4 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 33	Foot of 24th Street	3 Chiefs 18 Firefighters	1 pumper 1 fireboat
Station No. 34	7600 W. Jefferson	3 Chiefs 18 Firefighters	1 pumper
Station No. 35	1041 Lawndale	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 36	642 S. Bayside	3 Chiefs 18 Firefighters	1 pumper
Station No. 37	2820 Central	3 Chiefs 18 Firefighters	1 pumper
Station No. 38	2345 E. Davidson	3 Chiefs 18 Firefighters	1 pumper
Station No. 39	17475 Mt. Elliott	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 40	7 Mile Rd. & John Rd.	4 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 41	18326 Livernois	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 42	18601 Ryan Rd	3 Chiefs 18 Firefighters	1 pumper

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Table 1 (Continued)

Facility Location	Address	Personnel	Trucks
Station No. 43	10325 Linwood	4 Chiefs 36 Firefighters	1 pumper 1 ladder truck
Station No. 44	1405 Taylor	3 Chiefs 18 Firefighters	1 pumper
Station No. 45	111 Kenilworth	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 46	14001 - 12th Street	3 Chiefs 50 Firefighters	1 pumper 1 ladder truck 1 squad truck
Station No. 47	12985 Houston	4 Chiefs 50 Firefighters	1 pumper 1 ladder truck 1 squad truck
Station No. 48	10800 Whittier	3 Chiefs 18 Firefighters	1 pumper
Station No. 49	5029 Manistique	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 50	19701 Hoover	3 Chiefs 18 Firefighters	1 pumper
Station No. 51	16543 Meyers	3 Chiefs 18 Firefighters	1 pumper
Station No. 52	16825 Trinity	3 Chiefs 34 Firefighters	1 pumper 1 ladder truck
Station No. 53	15127 Greenfield	3 Chiefs 50 Firefighters	1 pumper 1 ladder truck 1 squad truck
Station No. 54	17800 Curtis	4 Chiefs 18 Firefighters	1 pumper
Station No. 55	545 E. Lafayette	4 Chiefs 36 Firefighters	1 pumper 1 snorkle
Station No. 56	City Airport	3 Firefighters	1 pumper

Table 1a

DETROIT FIRE DEPARTMENT PERSONNEL
IN CONTROL CENTERS

Main Control Center

Chief of Fire Department
Assistant Fire Chief
5 Battalion Fire Chiefs
Fire Marshal
Chief of Civil Defense
Chief of Training
Chief of Apparatus
Fire Water System Inspector
Supervising Fire Dispatcher
Architectural Engineer
2 Senior Officers of the Fire Marshal Division
1 Senior Officer of the Apparatus Division
4 Chief's Aides
6 Fire Dispatchers
10 Administrative Division Clerks*
2 Members of Civil Defense Division

Alternate Control Center

Deputy Chief of Department
Assistant Fire Chief
7 Battalion Fire Chiefs
Assistant Fire Marshal
Assistant Chief of Apparatus
Captain of Training
Senior Fire Dispatcher
Senior Fire Inspector
2 Senior Officers of the Fire Marshall Division
1 Senior Officer of the Apparatus Division
4 Chief's Aides
5 Fire Dispatchers
8 Fire Marshal Division Clerks

*The ten clerks of the Fire Department Administrative Division are shown in their Fire-Service assignment here, but may be located elsewhere since they are also assigned to the Welfare Service for Civil Defense purposes.

Section 3
POSTATTACK CONDITION OF ALL FIRE-SERVICE PERSONNEL

Casualty curves have been developed for various building types by several investigators (Refs. 2, 7, and 8). By means of these curves, the number of survivors and their condition may be estimated for the shelter buildings of interest. It has been assumed that fire department personnel suffer casualties in the same ratio as the general population. Wherever necessary, specific mortalities and casualties in a group of personnel were assigned randomly. Overpressure levels associated with locations may be seen in Fig. 1.

It has generally been assumed that the only personnel available for duty after the hypothetical attack are those in the uninjured category. A complete listing of the various casualty categories has been given, however, since some of the injured personnel could be available for duty after a short period of medical treatment, and in some cases even injured firemen may be capable of performing normally.

Table 2 presents the location and condition of all fire-service personnel after the attack. A summary of the condition and general location of all Firefighting Division personnel is given in Table 3.

The casualty numbers given in Tables 2 and 3 are for blast effects only. Preliminary casualty estimates have been made by Dikewood (Ref. 9) for fallout effects. Injuries due to fallout effects would generally not become apparent for some time, and thus it is expected that firemen in this category would be available for duty in the immediate postattack period. Assuming that the fire department personnel are affected in a manner similar to the general Detroit population results in an estimated 53 fallout injuries for the fire-service personnel.

Table 2
CONDITION AND LOCATION OF DETROIT FIRE DEPARTMENT PERSONNEL, AFTER POSTULATED ATTACK

Table 2 (Continued)

FACILITY LOCATION	KILLED	NONAMBULATORY SERIOUSLY INJURED	AMBULATORY SERIOUSLY INJURED	C O N D I T I O N		UNINJURED
				WAGHTMAN INJURED	TRAMPED	
<u>Diversed Mobilization Points</u>						
2-D Utica	---	---	---	---	---	2 Battalion Chiefs 10 Firefighters
4-D Richmond	---	---	---	---	---	2 Battalion Chiefs 1 Physician 10 Firefighters
6-D Flat Rock	---	---	---	---	---	2 Battalion Chiefs 1 Physician 8 Firefighters
8-D Northville	---	---	---	---	---	2 Battalion Chiefs 10 Firefighters
10-D Bloomfield	---	---	---	---	---	2 Battalion Chiefs 1 Physician 10 Firefighters
12-Rochester	---	---	---	---	---	2 Battalion Chiefs 10 Firefighters
<u>Fire Station No.</u>						
1	4 Fire Mar- shal Div. 5 Firefighters	1 Firefighter	1 Firefighter	17 Fire Mar- shal Div. 1 Chief*	1 Fire Mar- shal Div.	0 Fire Marshal Div. Water Supply Dept. 1 Chief 6 Firefighters
2	4 Firefighters	1 Firefighter	---	10 Firefighters 11 Firefighters	---	2 Chiefs 2 Firefighters 2 Firefighters
3	1 Chief 3 Firefighters 1 Firefighter	---	1 Firefighter	1 Chief 2 Firefighters	1 Firefighter	2 Chiefs 7 Firefighters
4	2 Chiefs 4 Firefighters	---	1 Firefighter	0 Firefighters	---	---
5	19 Firefighters 2 Chiefs 6 Firefighters	---	1 Firefighter	3 Firefighters	1 Firefighter	---
6	---	---	---	1 Chief	---	---
7	---	---	1 Firefighter	1 Firefighter	---	---

*The word chief in this table is to denote officer-level personnel.

Table 2 (Continued)

FACILITY LOCATION	KILLED	NONAMBULATORY SERIOUSLY INJURED	C O N D I T I O N				UNINJURED
			AMBULATORY SERIOUSLY INJURED	LIGHTLY INJURED	TUNED	WOUNDED	
Fire Station No.							
8	1 Chief	---	---	1 Chief	---	---	6 Firefighters
9	1 Firefighter	1 Firefighter	---	3 Firefighters	---	---	1 Chief
10	1 Firefighter	---	1 Firefighter	1 Chief	---	---	9 Firefighters
11	1 Firefighter	---	---	7 Firefighters	---	---	1 Chief
12	---	---	1 Firefighter	1 Chief	4 Firefighters	---	3 Firefighters
13	1 Firefighter	1 Firefighter	1 Firefighter	1 Chief	5 Firefighters	---	1 Chief
14	1 Chief	---	---	4 Firefighters	---	---	3 Firefighters
15	1 Chief	---	---	2 Chiefs	---	---	2 Chiefs
16	7 Firefighters	1 Firefighter	1 Firefighter	7 Firefighters	---	---	5 Firefighters
17	2 Firefighters	1 Firefighter	1 Chief	1 Chief	10 Firefighters	1 Firefighter	1 Chief
18	1 Chief	---	---	9 Firefighters	---	---	5 Firefighters
19	2 Firefighters	---	1 Firefighter	1 Chief	---	---	6 Firefighters
20	2 Chiefs	---	1 Firefighter	8 Firefighters	---	8 Firefighters	1 Chief
21	14 Firefighters	2 Chiefs	1 Firefighter	3 Firefighters	1 Firefighter	2 Chiefs	1 Firefighter
22	9 Firefighters	2 Chiefs	---	2 Firefighters	1 Firefighter	1 Firefighter	---
23	2 Chiefs	1 Firefighter	1 Firefighter	2 Firefighters	---	---	2 Chiefs
	2 Training Div.	14 Firefighters	2 Firefighters	2 Firefighters	---	---	2 Training Div.

Table 2 (Continued)

FACILITY LOCATION	KILLED	C O N D I T I O N				
		NONAMBULATORY SERIOUSLY INJURED	AMBULATORY SERIOUSLY INJURED	LIGHTLY INJURED	TRAPPED	UNINJURED
Fire Station No.						
24	1 Chief 9 Firefighters	1 Firefighter	1 Firefighter	1 Chief 5 Firefighters	1 Firefighter	1 Firefighter
25	2 Chiefs 9 Firefighters	---	---	---	---	---
26	---	---	---	7 Firefighters	---	2 Chiefs 11 Firefighters
27	---	---	---	4 Firefighters	---	2 Chiefs 13 Firefighters
28	1 Firefighter	---	---	1 Chief 2 Firefighters	---	1 Chief 6 Firefighters
29	---	---	---	3 Firefighters	---	2 Chiefs 6 Firefighters
30	1 Firefighter	---	---	1 Chief 5 Firefighters	---	1 Chief 11 Firefighters
31	6 Firefighters	1 Firefighter	1 Firefighter	1 Chief 1 Firefighter	1 Chief 1 Firefighter	---
32	16 Firefighters	1 Firefighter	1 Firefighter	1 Chiefs	---	---
33	6 Firefighters	---	1 Firefighter	1 Chief 2 Firefighters	1 Chief	---
34	2 Chiefs 5 Firefighters	---	1 Firefighter	2 Firefighters	1 Firefighter	---
35	2 Chiefs 14 Firefighters	---	1 Firefighter	2 Firefighters	---	---
36	1 Chief 6 Firefighters	---	1 Chief	2 Firefighters	1 Firefighter	---
37	2 Chiefs 9 Firefighters	---	---	---	---	6 Firefighters
38	---	---	2 Chiefs 3 Firefighters	---	3 Firefighters	1 Chief 11 Firefighters
39	1 Firefighter	---	---	5 Firefighters	---	2 Chiefs 8 Firefighters
40	1 Firefighter	---	1 Firefighter	8 Firefighters	---	8 Firefighters

Table 2 (Continued)

FACILITY LOCATION	KILLED	NONAMBULATORY SERIOUSLY INJURED	AMBULATORY SERIOUSLY INJURED	C O N D I T I O N			UNINJURED
				LIGHTLY INJURED	TRAPPED		
Fire Station No.							
41	1 Firefighter	---	---	2 Chiefs 6 Firefighters	---		10 Firefighters
42	1 Firefighter	---	---	1 Chief	---	1 Chief	5 Firefighters
43	1 Chief 9 Firefighters	1 Firefighter	1 Firefighter	3 Firefighters 5 Firefighters	1 Chief	2 Firefighters	
44	1 Chief 4 Firefighters	1 Chief	1 Firefighter	3 Firefighters	1 Firefighter	---	
45	2 Firefighters	1 Firefighter	---	1 Chief 9 Firefighters	1 Firefighter	1 Chief	5 Firefighters
46	7 Firefighters	---	---	13 Firefighters	---	2 Chiefs	5 Firefighters
47	---	---	---	5 Firefighters	---	2 Chiefs	20 Firefighters
48	---	---	---	2 Firefighters	---	2 Chiefs	7 Firefighters
49	---	---	---	1 Chief	---	1 Chief	14 Firefighters
50	---	---	---	3 Firefighters 2 Firefighters	---	2 Chiefs	7 Firefighters
51	1 Firefighter	---	1 Firefighter	1 Chief 4 Firefighters	---	4 Firefighters	
52	1 Firefighter	---	---	8 Firefighters	---	2 Chiefs	8 Firefighters
53	4 Firefighters	1 Firefighter	---	12 Firefighters	---	1 Chief	8 Firefighters
54	1 Chief	---	1 Firefighter	1 Chief 3 Firefighters	---	5 Firefighters	
55	2 Firefighters	---	---	2 Chiefs 7 Firefighters	---	0 Firefighters	
56	---	---	---	1 Firefighter	---	1 Firefighter	

Table 3
SUMMARY OF POSTATTACK CONDITION OF DETROIT FIRE DEPARTMENT PERSONNEL

		CONDITION				
	KILLED	NON-AMBULATORY SERIOUSLY INJURED	AMBULATORY SERIOUSLY INJURED	LIGHTLY INJURED	TRAPPED	UNINJURED
<u>On-duty personnel</u> <u>located in shelters</u> <u>at or near their</u> <u>duty stations</u> <u>(firehouses):</u>						
Chiefs*	30 231	1 13	2 22	33 255	3 9	63 336
<u>Off-duty personnel</u> <u>located in shelters</u> <u>at random around the</u> <u>city:</u>						
Chiefs	21 200	1 12	1 19	22 241	1 12	20 326
<u>Total of all Fire-</u> <u>fighting Division</u> <u>personnel:</u>						
Chiefs	51	2	3	55	4	83
Firefighters	431	25	41	496	21	662

*The word chief as used in this table is to denote officer-level personnel.

Section 4
DAMAGE ESTIMATES FOR FIRE-SERVICE FACILITIES

Facilities of the Detroit Fire Department include Control Centers, Dispersed Mobilization Points, Fire Department Headquarters, Fire Stations, the Apparatus-Building Supplies Center, the Training Academy, Central Communications, and the Water Supply System.

The Water Supply System is actually under the jurisdiction of the Detroit Department of Water Supply (Ref. 10) but is vital to effective fire department operations and is therefore included. A preliminary evaluation indicates that damage to the Water Supply System would be quite severe. More than one-third of the city experiences over 5 psi overpressure. This area would thus have general loss of water pressure because of damage to the water treatment plant located at Water Works Park (over 10 psi) and extensive piping damage due primarily to collapsed structures. In addition, the System Control Station experiences 4 psi overpressure and other important system elements (the Central Service Center, the southwest water treatment plant, and three reservoir and repumping stations) are in the 2- to 4-psi region. In light of the above, it is expected that water pressure might be lost over the entire city or else available only in about one-third of the city and then only at low pressure. Drafting from open bodies of water such as rivers would be difficult due to access problems and would have very limited usefulness. The only other identified fire department water supply would be the 5,000-gallon cistern at the Training Academy, which would be exposed to over 10 psi overpressure, and its usefulness is questionable. (At any rate it is inaccessible and too far from where the demands are.)

Damage estimates for the various fire department facilities have been made utilizing the URS building damage prediction methods (Ref. 11). The facilities are primarily brick load-bearing buildings with similar response characteristics. On a gross basis, buildings experiencing less than 1-1/2 psi

are considered completely operable since the only damage would be some windows broken. Buildings which are exposed to 4 - 5 psi are considered completely inoperable (although most of these buildings would still be standing, they would be too hazardous for any use by the Fire Department). The intermediate range of overpressure conditions (1-1/2 - 4 psi) would yield buildings only partially usable and appropriate overpressure ranges have been identified with corresponding damage levels.

The Main Control Center escapes essentially undamaged (although it experiences about 4 psi, it has a design rating for 18 psi). The Alternate Control Center and all Dispersed Mobilization Points are completely usable since they all are beyond the range of 1 psi overpressure. The fire department facilities are indicated in Fig. 2, which also gives the postattack condition of each in terms of usable facilities and the nature of damage to the unusable facilities. Not shown in Fig. 2 are the Alternate Control Center and Dispersed Mobilization Points, which are outside the range of the map and which all are completely operable postattack. The damage symbols used in Fig. 2 are identified as follows:

- Completely operable (except some windows broken)
- Firehouse doors jammed (or otherwise inoperable) plus some light damage such as loss of windows and light interior partitions
- Exterior walls cracked and partially blown out
- Roof disrupted and partially removed
- Completely inoperable

The damage descriptions shown above are additive with increasing overpressure; for example, where a fire department has experienced exterior wall cracking, the lower overpressure damage to doors, etc., would also be present.

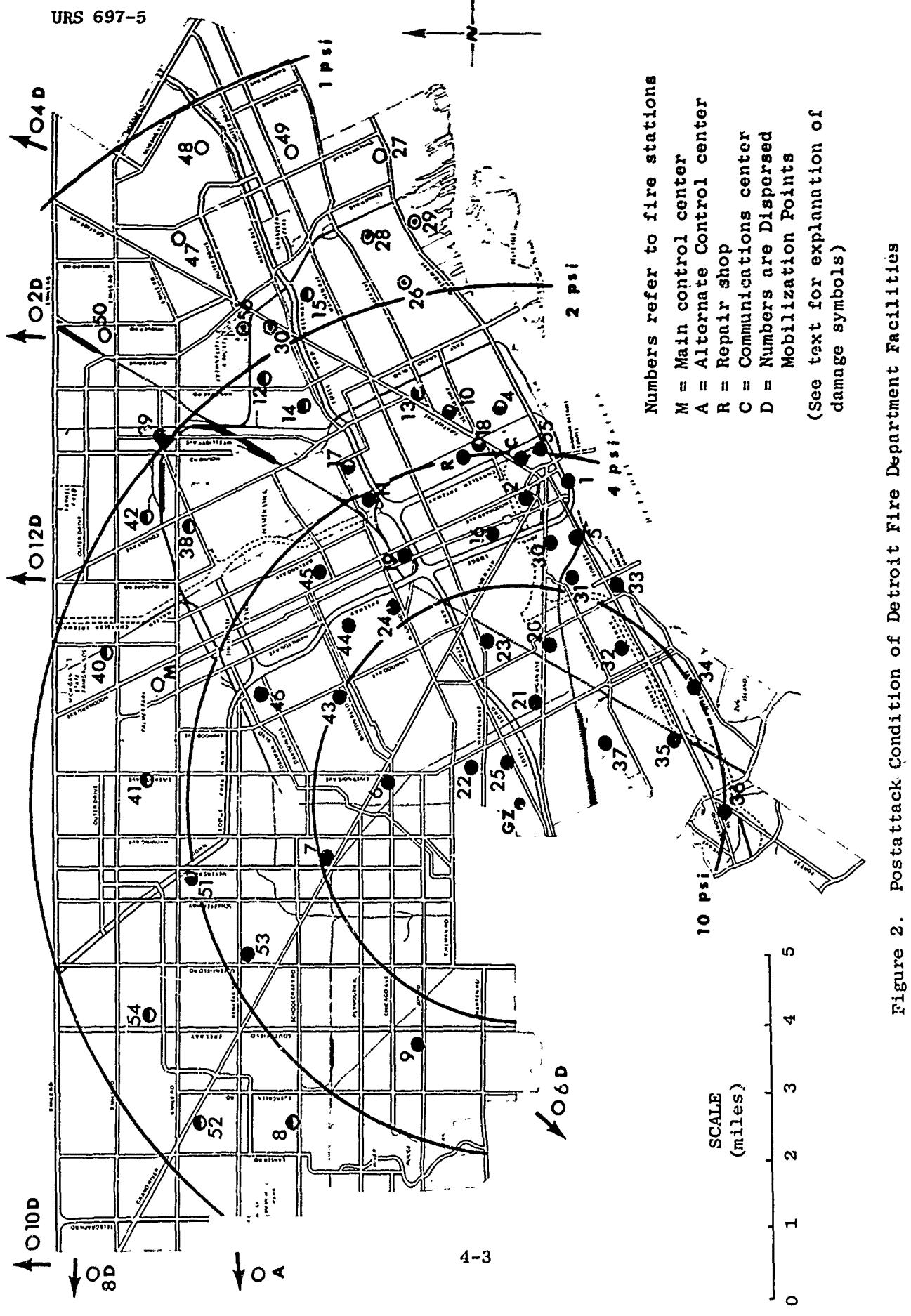


Figure 2. Postattack Condition of Detroit Fire Department Facilities

Section 5
DAMAGE ESTIMATES FOR FIRE-SERVICE TRUCKS

Damage to fire-service mobile equipment must be estimated for two distinct categories. First, for mobile equipment located inside (or immediately adjacent to) the fire department facilities, damage depends almost totally on damage to the facility itself. Second, for mobile equipment located outside (and sufficiently separated from surrounding structures to be unaffected by damage to the structures), a separate damage function related to overpressure is used (Ref. 2).

For vehicles inside facilities, the following damage levels apply:

<u>Overpressure (psi)</u>	<u>Damage Description</u>
0 - 1-1/2	Completely operable except some windows broken
1-1/2 - 2-1/2	Light damage such as broken windows, bent and dented hood, fenders and compartment doors up to a half hour may be needed to restore operability)
2-1/2 - 4	Moderate damage such as wheels and/or engine damaged (1 to 2 hours required to restore operability)
4 - 5	Destroyed (or at least trapped in damaged building)

The trucks of the Detroit Fire Department are assumed to be all stationed inside their normal facilities with the exception of mobile equipment dispatched to the Dispersed Mobilization Points.

The location and condition of all Fire-Service trucks after the postulated attack are given in Table 4.

Table 4
POSTATTACK LOCATION AND CONDITION OF FIRE-SERVICE TRUCKS

Location	DAMAGE CONDITION			
	Completely Usable	Light Damage	Moderate Damage	Inoperable
<u>Dispersed Mobilization Points:</u>				
2-D Utica	2 pumpers 1 ladder truck 1 boat tender 1 disaster unit			
4-D Richmond	2 pumpers 1 ladder truck 1 squad truck 1 foam truck			
6-D Flat Rock	2 pumpers 1 ladder truck 1 disaster unit			
8-D Northville	2 pumpers 1 ladder truck 1 squad truck 1 foam truck			
10-D Bloomfield	2 pumpers 1 ladder truck 1 hose truck 1 foam truck			
12-D Rochester	2 pumpers 1 ladder truck 1 squad truck 1 foam truck			
<u>Numbered Fire Stations:</u>				
1				1 pumper 1 ladder truck 1 squad truck 1 boat tender 1 ambulance
2				1 pumper 1 ladder truck
3				1 pumper

Table 4 (Continued)

Location	DAMAGE CONDITION			
	Completely Usable	Light Damage	Moderate Damage	Inoperable
4			1 pumper 1 ladder truck	
5				1 ladder truck
6				1 pumper 1 ladder truck
7				1 pumper
8			1 pumper	
9				1 pumper 1 ladder truck
10			1 pumper	
11				1 pumper
12		1 pumper		
13			1 pumper 1 ladder truck	
14			1 pumper 1 ladder truck	
15		1 ladder truck		
16				1 pumper 1 ladder truck 1 squad truck
17			1 pumper 1 ladder truck	
18			1 pumper	
19				1 pumper 1 ladder truck
20				1 pumper 1 ladder truck
21				1 pumper
22				1 pumper

Table 4 (Continued)

Location	DAMAGE CONDITION			
	Completely Usable	Light Damage	Moderate Damage	Inoperable
23				1 pumper 1 ladder truck 1 light unit
24				1 pumper 1 squad truck
25				1 ladder truck
26		1 pumper 1 ladder truck		
27	1 pumper 1 ladder truck			
28		1 pumper		
29		1 pumper		
30		1 pumper 1 squad truck		
31				1 pumper
32				1 pumper 1 ladder truck
33				1 pumper 1 fireboat
34				1 pumper
35				1 pumper 1 ladder truck
36				1 pumper
37				1 pumper
38			1 pumper	
39		1 pumper 1 ladder truck		
40		1 pumper 1 ladder truck		

Table 4 (Continued)

Location	DAMAGE CONDITION			
	Completely Usable	Light Damage	Moderate Damage	Inoperable
41			1 pumper 1 ladder truck	
42		1 pumper		
43				1 pumper 1 ladder truck
44				1 pumper
45				1 pumper 1 ladder truck
46				1 pumper 1 ladder truck 1 squad truck
47	1 pumper 1 ladder truck 1 squad truck			
48	1 pumper			
49	1 pumper 1 ladder truck			
50	1 pumper			
51			1 pumper	
52		1 pumper 1 ladder truck		
53				1 pumper 1 ladder truck 1 squad truck
54		1 pumper		
55				1 pumper 1 snorkle
56		1 pumper		

A summary of the condition of all fire-service trucks is given in Table 5. This summary applies for all trucks assumed to be stationed inside the fire-service facilities. The last item given in Table 5 shows a summary of damage to trucks if instead they had all been stationed outside of the facilities.

Table 5
SUMMARY OF DAMAGE TO FIRE-SERVICE TRUCKS

Type of Truck	DAMAGE CONDITION			
	Completely Usable	Light Damage	Moderate Damage	Inoperable
Pumpers	17	11	10	27
Ladder trucks	9	5	5	16
Squad trucks	4	1	--	5
Foam trucks	4	--	--	--
Disaster units	2	--	--	--
Snorkel	--	--	--	1
Light unit	--	--	--	1
Hose truck	1	--	--	--
Ambulance	--	--	--	1
Boat tender	1	--	--	--
Boat	--	--	--	1
Total trucks (located inside)	38	17	15	53
Total trucks if located outside, in open areas	56	23	26	18

Section 6
OTHER FIRE DEPARTMENTS IN THE DETROIT AREA

In addition to the City of Detroit Fire Department, a number of other cities outside of Detroit (or actually within the Detroit city limits in the case of Highland Park and Hamtramck) have professional fire departments which should be considered. Only those cities within 10 miles of the Detroit city limits are included since the fire departments of more distant cities would require excessive time to respond to a Detroit need and/or would have more pressing local requirements.*

Table 6 presents a summary of the personnel, facilities, and trucks for the fire departments of each of the cities (Ref. 12). Damage estimates for these fire departments have been conducted using the following assumptions in the absence of detailed information for the cities involved:

1. Fire stations are located randomly in the cities, but those of each city are assigned equal areas to protect.
2. Fire stations are all assumed to be of brick load-bearing construction.
3. All fire-service personnel are located at or near the fire stations and experience casualties similar to the Detroit general population located at corresponding overpressure levels.
4. All fire department vehicles are located within the fire stations.

Some non-government fire departments in the area which have professional firemen and equipment may exist. Such fire departments have not been identified in this study. Any which do exist however, would probably have more problems than they could handle with the fire situation in the industries in which such fire departments are located.

*This had been done in spite of any mutual aid agreements with cities more distant than 10 miles.

Table 6
POSTATTACK LOCATION AND CONDITION OF RESOURCES FOR OTHER
FIRE DEPARTMENTS IN THE DETROIT AREA

City	Total Personnel	Casualties		Fire Stations		Vehicles	
		Killed	Injured	Number	Condition	Number	Condition
Allen Park	28	11	8	1	Moderate damage	8	Moderate damage
Birmingham	37	--	3	2	Usable	8	Usable
Dearborn	120	53	41	4	2 Moderately damaged 2 Inoperable	22	10 Moderately damaged 12 Inoperable
East Detroit	20	--	2	1	Usable	7	Usable
Ferndale	44	1	13	2	Light damage	10	Light damage
Garden City	14	1	3	1	Light damage	5	Light damage
Hamtramck	70	8	42	2	Moderate damage	7	Moderate damage
Hazel Park	22	--	7	1	Light damage	6	Light damage
Highland Park	108	11	60	3	2 Moderately damaged 1 Inoperable	8	6 Moderately damaged 2 Inoperable
Inkster	19	1	4	1	Light damage	5	Light damage
Lincoln Park	35	2	15	1	Moderate damage	8	Moderate damage
Livonia	64	--	6	4	3 Usable 1 Lightly damaged	9	6 Usable 3 Lightly damaged
Madison Heights	33	--	3	2	Usable	8	Usable
Oak Park	76	3	15	1	Light damage	6	Light damage
Roseville	36	--	2	2	Usable	12	Usable

Table 6 (Continued)

City	Total Personnel	Casualties		Fire Stations		Vehicles	
		Killed	Injured	Number	Condition	Number	Condition
Royal Oak	93	--	10	4	Usable	16	Usable
St. Clair Shores	58	--	3	3	Usable	13	Usable
Southfield	31	--	3	3	Usable	9	Usable
Southgate	14	1	3	1	Light damage	5	Light damage
Warren	124	1	15	5	Usable	27	Usable
Wyandotte	55	3	13	3	Light damage	10	Light damage
TOTALS	1101	96	271	47	25 Usable	209	106 Usable

Section 7

ANALYSIS OF REMAINING FIRE DEPARTMENT CAPABILITIES

This section will summarize the results of previous sections and attempt to analyze the remaining capabilities of the Detroit Fire Department. This analysis will include considerations of the magnitude of the demands on the fire department, obstacles hampering fire-service performance, and alternative actions by the fire department.

PERSONNEL

Top management personnel of the fire department would be essentially intact, with no casualties in their locations at the Control Centers and Dispersed Mobilization Points. Communications personnel similarly would suffer no casualties in their locations at the Control Centers. Operating personnel (mostly repairmen) of the Apparatus Division would have experienced casualties amounting to two-thirds their number, leaving 22 of the 66-man force available for duty. Of these, 11 are located near the repair shop and the other 11 are located randomly about the city. The Firefighting Division would have about 60% casualties, with just over one-quarter killed. The 40% of the Division which are available for duty exist in two groups. Just over half of them are located with their officers near their assigned fire stations, which would facilitate appropriate actions being taken by these men. The remainder are located randomly around the city and they could not immediately reach their assigned stations.

The 399 men of the Firefighting Division who are located near their assigned fire stations represent about three-quarters of the normal on-duty strength for these stations. This is an overstatement of the potential capabilities, however, since of the 56 fire stations involved, 14 would not have any available officers to direct operations and 18 would have insufficient manpower to properly operate any fire-service vehicles.

FACILITIES

The Control Centers and Dispersed Mobilization Points would all be completely operable. The Apparatus Repair Shop and the Communications Division Headquarters would both be completely inoperable. The 56 fire stations would be in the condition indicated as follows:

- 5 completely operable (except some windows broken)
- 6 with firehouse doors jammed or otherwise inoperable plus light damage such as loss of windows and light interior partitions
- 11 roof disrupted and partially removed
- 5 exterior walls cracked and partially blown out
- 29 completely inoperable

Based on the above, it can be seen that about 10% of the fire stations would be completely operable and an additional 10% would be operable after some repairs to firehouse doors, windows, and interior partitions. The remaining 80% of the fire stations, however, are inoperable and would mostly require complete rebuilding to restore operations.

TRUCKS

On an overall basis, just over 30% of all fire-service trucks would be completely operable after the postulated attack, with an additional 14% only lightly damaged and capable of being restored to operability within a half hour.

The immediate postattack difficulty would be the fact that most of the operable trucks are located at the Dispersed Mobilization Points. There would only be 9 completely operable trucks at the fire stations for immediate use, and this represents less than 10% of all fire-service vehicles. Even with the lightly damaged trucks quickly repaired or driven "as-is" the total available is only 26 (just over 20% of all). It appears that there will be a higher

percentage of personnel than trucks available for duty immediately after the postulated attack.

Clearly there are very important benefits to be derived from selecting the alternative posture of locating fire-service trucks outside the stations before the attack. Under such conditions nearly 50% of all trucks would be completely operable after the attack. In addition, there would now be a much larger number of operable trucks available within the city at the fire stations (27 trucks versus 9). As a valuable preattack measure, therefore, the Fire Department should locate all fire trucks outside the facilities to maximize chances for survival and make more trucks available after the attack.

DEMANDS ON THE FIRE-SERVICES

An examination of pertinent Fire-Behavior Model studies (Ref. 4 and 13) indicates that Detroit would experience a very large number of structural fires in the region between 3 and 5 psi overpressure. The probability of significant fire per residential structure would be about 0.2 at 4 psi, dropping off rapidly to zero at about 3 psi. This region encompasses on the order of a thousand blocks of residential structures in Detroit. Assuming no more than five residences per block (conservative) and an average ignition probability of 0.1, this would result in about 500 residential fires in this area alone. A demand situation of this magnitude could not be handled by the entire undegraded Detroit Fire Department and it is obvious that the fire services remaining after the hypothetical attack would be completely overwhelmed by the fire situation.

OBSTACLES TO FIRE-SERVICE ACTIVITIES

Fire-service activities performed in the postattack period would be hampered by the loss of resources as indicated above and by other factors such as radioactive fallout and structural debris.

As indicated previously, the fire department would ultimately experience 53 injuries due to fallout effects. This is based on the average injury rate

due to fallout in the Detroit area. With firefighters continually working outside in response to demands on the fire services, it could be expected that an even greater injury rate would be noted. The magnitude of the effect has, however, not even been estimated since it is expected that fire-service personnel will proceed with their duties and such injuries will probably not become evident until after urgent transattack activities have been completed.

An examination of debris contours for Detroit (Ref. 14) reveals that debris depths in excess of six inches cover a considerable portion of the city (about one-third), even out to overpressure levels below 4 psi in some areas. Such debris levels will result in greatly reduced mobility in these areas and would limit access to the wider streets.

POTENTIAL FIRE-SERVICE ACTIVITIES

Orthodox firefighting would require normal fire-reporting methods, full water pressure and supply, completely operable trucks with full crews and supporting officers, and completely free access to any part of the city. It is obvious that most of the above requirements are missing in the postattack situation and, therefore, orthodox firefighting cannot be carried out. In view of the overwhelming demands existing, the orthodox approach of fighting one fire at a time with large forces of firefighters should not be followed anyway. An examination of alternative actions for the fire services is appropriate (Refs. 2 and 15).

The fire-service personnel would probably serve the remaining population best by first supporting self-help firefighting activities in the shelters where firemen are located. Subsequently strategic shelters and shelter complexes could be protected from fire spreading from adjacent buildings. Another alternative for the fire services would be to concentrate forces at appropriate wide streets or other firebreaks in an attempt to stop the progress of a potential moving fire front which could form in the 3- to 4-psi region of the city. Finally, the fire services would assist in the general evacuation of personnel to safe areas by use of their communication system, trucks, and water screens to cool personnel in transit under the hostile heat conditions.

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The effectiveness of all of the above activities could be improved by coordination from the Control Centers and Dispersed Mobilization Points. In addition, the command, control and communication capabilities of the Control Centers and Dispersed Mobilization Points could be utilized in rescue of people. Additional analysis of these command and control factors is needed, but has not been performed in this study.

Section 8
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13. ABSTRACT This study examines damage to the Detroit Fire Department as a result of the Five-City-Study attack and analyzes the fire department capabilities in dealing with the postattack fire situation. After reviewing damage incurred by personnel, facilities, and equipment, the remaining fire-service resources were evaluated with respect to the magnitude of the demand situation and obstacles preventing the satisfaction of these demands. The evaluation considered strength and location of the fire services prior to the attack, casualties and damage incurred to the fire services as a result of the attack, and analysis of the remaining capabilities in the postattack period. The research yielded the following findings: (1) Firefighting personnel would experience total casualties on the order of 60% of their total number, (2) Only about 20% of the fire stations would be usable after the attack, control centers would be completely operable; (3) Approximately 30% of the fire trucks would be usable, less than 10% would be available within the city after the attack; (4) Stationing the fire trucks in open areas rather than inside fire stations would have increased their survival to about 50%; (5) In view of the inability of the fire-service personnel and equipment to deal with the postattack demands, it is recommended that orthodox firefighting be abandoned in favor of more limited, self-help-type activities stressing population survival and protection of critical areas.		

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